ENERGETICS OF MUSCLE ACTIVITY IN RELATION TO THE MOLECULAR PHYSIOLOGY OF THE CONTRACTION PROCESS

Wilfried F. H. M. Mommaerts

California University
Los Angeles, California

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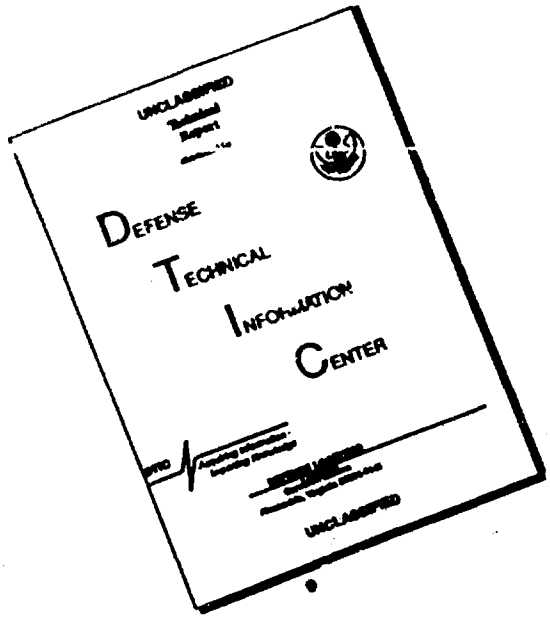

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Prin. Investigator: Wilfried F. H. M. Mommaerts
Institution: University of California
405 Hilgard Avenue
Los Angeles, California 90024

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The heat measuring techniques progressed to the stage where several significant investigations on the heat production during isometric contractions were carried out.

Activation heat, which is the heat produced in response to a stimulus when no tension or shortening is allowed, was determined by three different methods:

1. The heat is measured at successively shorter muscle lengths until the developed tension is very near zero. An extrapolation to zero tension gives the activation heat.

2. The tension is reduced to zero by uncoupling with deuterium oxide. The heat measured when no tension is developed is the activation heat.

3. The increment in heat is measured in response to a second stimulus given at a time when a new complete activation cycle is initiated but while the mechanical effects of the first are still present.

All three methods give essentially the same value of about 40% of the total heat in an isometric twitch which is in good agreement with earlier results of Hill and his colleagues. Equally significant is the fact that methods 2 and 3 have shown the activation heat to be independent of length. These results indicate that activation does not depend on the amount of overlap between the actin and myosin rods.

The first measurements of heat production of isolated papillary muscles have been accomplished due in large part to the development of very short, high sensitivity piles whose geometry have been adapted for this tissue.

This research was supported by the Biological Sciences Division, AFOSR, SRLA under ~~Contract~~/Grant AF-AFOSR-146-65

Resting heat rate has been found to be ten times that of skeletal muscle. At 20°C. and at resting length its value is 24.8 mcal/g. muscle x min. The relation between heat production and actually developed tension is similar to that of skeletal muscle. An extra amount of heat is produced when the muscle is allowed to shorten.

Preliminary results indicate that the rate of heat production in stimulated muscle is much slower than in skeletal muscles. This point is under further investigation.

Resulting Publications:

Gibbs, C. L., Mommaerts, W. F. H. M. and Ricchiuti. Energetics of Cardiac Contractions. J. Physiol. 191: 25-46 (1967).

Gibbs, C. L., Ricchiuti, N. V. and Mommaerts, W. F. H. M. Activation Heat in Frog Sartorius Muscle. J. Gen. Physiol. 49:3, 517-535 (1966).

Gibbs, C. L., Ricchiuti, N. V. and Brady, A. J. Heat Production of Rabbit Papillary Muscle. The Physiologist 8:3 (1965).

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Mommaerts, W. F. H. M. and Wallner, A. The Break-Down of Adenosine Triphosphate in the Contraction Cycle of the Frog Sartorius Muscle. J. Physiol. 193: 343-357 (1967).

Seraydarian, K. and Mommaerts, W. F. H. M. Density Gradient Separation of Sarcotubular Vesicles and Other Particulate Constituents of Rabbit Muscle. J. Cell Biol. 26:2, 641-656 (1965).

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13 ABSTRACT

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